

Claims:

1. A method of producing solid carbonaceous  $C_xH_y$ , wherein x and y are the average number of carbon and hydrogen atoms respectively and the ratio of x:y is greater than 2.5:1, wherein a hydrocarbon fuel (comprising bulk feedstock fuel and flame fuel) is heated with oxygen at a C:O stoichiometric ratio greater than 1:1, preferably greater than or equal to 1:0.2, to a temperature of at least about 1000°C whereby to effect incomplete combustion and pyrolytic decomposition of said hydrocarbon fuel.
2. A method as claimed in claim 1 wherein the value of x in the x:y ratio exceeds 40.
3. A method as claimed in claim 1 or 2 comprising at least the steps of pre-heating the bulk feedstock fuel and passing said bulk feedstock fuel into a reactor in which said bulk feedstock fuel is rapidly heated to a temperature of between about 1000 and 2000°C for between 0.1 and 10 seconds by interspersing said bulk feedstock fuel with air- or oxygen-assisted hydrocarbon flames utilizing said flame fuel, to obtain localized heating whereby to effect partial pyrolytic decomposition.
4. A method as claimed in any one of claims 1 to 3 wherein said bulk stock fuel and flame fuel are the same or different, and said temperature of 1000°C is achieved by combustion of the flame fuel which is mixed with, or separate to, the bulk feedstock fuel.
5. A method as claimed in claim 4 wherein said bulk feedstock fuel and flame fuel are the same or different and are mixed together, and said temperature of 1000°C is achieved by ignition of the hydrocarbon fuel causing localised combustion of the flame fuel within said bulk

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feedstock fuel.

6. A method as claimed in any one of claims 1 to 5 wherein the combustion products are interspersed with the feedstock fuel by the use of turbulence.

7. A method as claimed in claim 6 wherein turbulence is achieved by introducing one or more of the flame, combustion products, flame gas, oxidizer, hydrocarbon fuel or feedstock fuel into the reactor at a velocity of 20-200m/s.

8. A method as claimed in any one of claims 1 to 7 wherein the feedstock fuel is comprised of one or more gaseous hydrocarbons.

9. A method as claimed in any one of claims 1 to 7 wherein the feedstock fuel is natural gas.

10. A solid carbonaceous product obtainable by the method described in any one of claims 1 to 9.

11. A method of producing a hydrogen-rich gas with a H:C stoichiometric ratio equal to or exceeding 20:1, and a H:O stoichiometric ratio greater or equal to 5:1, wherein a hydrocarbon fuel is heated with oxygen at a C:O stoichiometric ratio greater than 1:1, preferably greater than or equal to 1:0.2, to a temperature of at least about 1000°C whereby to effect partial pyrolytic decomposition of said hydrocarbon fuel according to the method as defined in any one of claims 1 or 3 to 9.

12. A method of combustion wherein the hydrogen-rich gas produced according to the method of claim 11 is combusted.

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13. A reactor for performing the method described in any one of claims 1 to 9 or 11 or 12 comprising at least: one or more inlet ports allowing entry of the hydrocarbon fuel into the reactor cavity, one or more outlet ports through which evolved gas may leave the reactor and a source of ignition whereby to effect partial combustion of hydrocarbons introduced into said reactor or associated burner.

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